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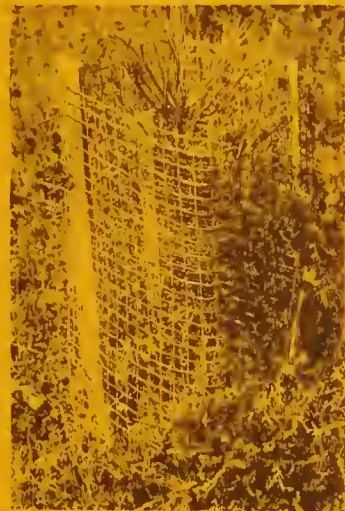
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reclamation of nonsprouting greenleaf manzanita brushfields in the cascade range

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PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
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INTRODUCTION

Several species of manzanita are found in the Cascade Range, but a nonsprouting form of greenleaf manzanita (*Arctostaphylos patula* Greene)^{1/} is of special concern to foresters in southwestern Oregon. Although it commonly occurs as scattered plants or clumps in mixture with other brush species, dense, relatively pure stands of this manzanita occupy extensive areas of commercial forest land in the southern half of the Cascade Range.

Areas of such manzanita-infested forest land are especially prevalent on pumice and other volcanic soils in the vicinity of Mount McLoughlin on the Rogue River National Forest,

^{1/} Exact identity of this manzanita has not yet been established. It has been variously identified as greenleaf manzanita (*Arctostaphylos patula* Greene) and Howell manzanita (*A. hispidula* Howell). It is probably an ecotype of the greenleafed manzanita prevalent in central Oregon that has also been identified or listed as *A. patula* Greene, as pine manzanita (*A. parryana* var. *pinetorum* (Rollins) Wiesel. & Schr.), as *A. patula* Greene ssp. *platphylla* (Gray) P. V. Wells, and as *A. obtusifolia* Piper. The nonsprouting characteristic, as compared to sprouting of the burred form of greenleaf manzanita in the Siskiyou Mountains, is of special interest to foresters; this nonsprouting greenleafed manzanita can be killed with herbicides at far less cost.

where mixed stands of ponderosa pine and Douglas-fir were railroad-logged during 1920-25. The extensive cut-over areas failed to restock naturally with conifers. Instead, the disturbed areas were occupied by greenleaf manzanita that held the sites in a non-productive condition for more than 30 years.

This research paper gives results of small plot and aerial tests of herbicides on this manzanita and provides information on mechanical eradication as a reclamation method for the manzanita brushfields. The latter information is based upon approximately 10 years of practical experience on the Rogue River National Forest.

EXPERIMENTS WITH HERBICIDES

Tests With Ground Spray Equipment

Modern herbicides were considered especially promising for low-cost control of manzanitas in the mid-1950's; therefore, a screening test was set up to determine the effect of 2,4-D and 2,4,5-T on mature shrubs of this nonsprouting greenleaf manzanita.^{2/} Random samples of 20 shrubs each were sprayed to drip point during late July with one of six different formulations of low-volatile propylene glycol butyl ether (PGBE) esters^{3/} of 2,4-D or 2,4,5-T (table 1). Each herbicide was tested

^{2/}Gratkowski, H. Effects of herbicides on some important brush species in southwestern Oregon. U.S.D.A. Forest Serv., Pacific Northwest Forest and Range Exp. Sta. Res. Pap. 31, 33 pp., illus. 1959.

^{3/}Commercial formulations of these herbicides were supplied by the Dow Chemical Company. Their cooperation is sincerely appreciated.

Table 1.--Effects of a midsummer foliage spray of herbicides on non-sprouting greenleaf manzanita in the Cascade Range

Treatment			Total plants sprayed	Plants with basal sprouts	Percentage of kill	
Herbicide	Concentration	Carrier			Top ^{1/}	Complete plant ^{2/}
Aehg ^{3/}			Number	Percent	Percent	Percent
2,4-D	1	Water	20	0	99	85
2,4-D	1	Emulsion ^{4/}	20	0	97	80
2,4-D	2	Water	20	0	100	95
2,4-D	2	Emulsion ^{4/}	20	0	99	100
2,4,5-T	2	Water	20	0	96	85
2,4,5-T	2	Emulsion ^{4/}	20	0	95	95

^{1/} Percentage of crown dead 3 months after spraying.

^{2/} Percentage of shrubs completely dead 14 months after spraying; only a few green twigs were present on shrubs still alive at that time.

^{3/} Pounds acid equivalent per hundred gallons.

^{4/} 5 percent diesel oil.

in water carriers and in oil-in-water emulsions containing 5 percent black diesel oil by volume. New shoots were 2 to 3 inches long at time of treatment, most new leaves were fully developed, and berries were full size.

The tests (table 1) show that this nonsprouting form of greenleaf manzanita is readily killed with one application of either 2,4-D or 2,4,5-T, but 2,4-D is more effective and economical. Diesel oil emulsions were no more effective than water as a carrier for the phenoxy herbicides, but thorough coverage was more easily obtained with the emulsion. Complete spray coverage of all foliage on the exterior of the crown proved advisable, for ends of branches missed or sprayed too lightly remained alive for years after treatment, even though the rest of the crown died.

However, flagged plants^{4/} in the screening tests did not resprout from other stems or from root crowns, and brush competition with associated conifers was appreciably reduced.

Next, a small, replicated minimum dosage test was installed during 1956 to determine the least amount of 2,4-D required per acre to insure a satisfactory kill of this green-leaved manzanita. A commercial formulation of low-volatile PGBE esters of 2,4-D was applied with a knapsack sprayer on replicated 1/100th-acre plots at rates of 1, 2, and 4 pounds ae^{5/} per acre in

^{4/} Plants with leaves that survived the spray treatment or with live stem sprouts produced after spraying.

^{5/} Acid equivalent.

water and in emulsion carriers. Although this series of plots was destroyed in a mechanical brush clearing project before final evaluation, preliminary observation a year after treatment indicated that the minimum required dosage of 2,4-D was 2 to 4 pounds ae per acre in midsummer foliage spraying. This information was used in a 100-acre test of aerial spraying to control manzanita on the Rogue River National Forest.

Aerial Spraying

Three large plots were marked for aerial spraying on a manzanita-covered flat approximately 6 miles southeast of Butte Falls, Oregon. One plot was 60 acres in size; each of the other two was 20 acres. A small number of ponderosa pines (*Pinus ponderosa* Laws.) and Douglas-firs (*Pseudotsuga menziesii* (Mirb.) Franco) ranging from 2 to 25 feet in height were present on all three areas.

All three areas were sprayed with commercial formulations of isoocetyl esters of phenoxy herbicides from a fixed-wing biplane on June 10, 1958 (table 2). The herbicides were applied in oil-in-water emulsions containing 1 gallon of black diesel oil in a total of 7 gallons of spray per acre. Weather conditions during spraying were partially overcast, cool, and calm. The manzanita shrubs were growing, a condition in which they were easily killed in screening tests.

Briefly, the aerial spray trials (table 2) indicate that a late spring aerial application of 3 pounds ae of low-volatile esters of 2,4-D per acre will insure an almost complete kill of this nonsprouting form of green-leaf manzanita in southwestern Oregon. Four pounds of 2,4-D per acre killed 96 percent of the large, mature manzanita shrubs; 2 pounds killed only 74 percent. Only a negligible amount of living foliage was found on surviving plants in the latter area, and none of these had basal sprouts. These

results indicate that aerial application of 3 pounds ae of 2,4-D per acre will produce an acceptable degree of control for this species in brushfield reclamation projects. Helicopter application of this treatment would now cost about \$6.50, including cost of chemicals, administration, and application of 8 gallons of spray per acre.

Both ponderosa pines and Douglas-firs on these spray areas sustained damage from the June treatment. Pines were more severely damaged than firs.

Reforestation After Aerial Spraying

Although aerial spraying is an effective method for killing this manzanita, brush control is only the first phase of any brushfield reclamation project. Reforestation is the second phase, and experience on this project has shown that animal damage can eliminate any conifers planted or seeded on a site and render useless even a perfect job of brush control.

Portions of the sprayed plots were planted with both ponderosa pine and Douglas-fir seedlings during the first fall after spraying. Almost all manzanita foliage was dead, and stems of the shrubs had died back about one-fifth of their length by the time the areas were planted. Before planting, cattle trampling and deer browsing of young trees were considered potential dangers to young conifers planted in the spray area. Therefore, the seedlings were planted under the crowns of the sprayed manzanita shrubs with the idea that the shrubs would die, harden, and form a natural barricade protecting the trees from deer browsing and cattle trampling. Unfortunately, rabbits were numerous on the site, and the plantings failed. The chemically killed brush evidently provided enough cover so that rabbits felt safe from predators and moved about freely beneath the dead brush. Three weeks after the areas were planted, a survey

Table 2.--Effect of early June aerial applications of herbicides on nonsprouting greenleaf manzanita

Treatment		Acres	Shrubs with stem sprouts	Shrub kill	
Chemical	Pounds/acre			Aerial parts	Complete plant
-----Ae ^{1/} -----				-----Percentage-----	
2,4-D	2	20	26	97	74
2,4-D	4	60	4	<u>2/</u> 100	96
2,4-D	2				
plus		20	4	<u>2/</u> 100	96
2,4,5-T	1				

^{1/}Acid equivalent.

^{2/}A few stem tips were alive on 2 of the 50 plants examined in each of these treatments.

revealed that 95 percent of the trees had been clipped off near ground level.

After this experience, District personnel decided that the dead brush would have to be windrowed and burned to eliminate the cover for rabbits before planting. With loose, sandy soil and dead brush, the clearing cost was only \$15 to \$18 per acre. The area was again replanted in the spring of 1963, and baiting for rabbits and rodents was provided as a continuing program. Survival from this planting ranged from a high of 60 percent in some areas to a low of 5 percent in others. Rabbits, deer, and gophers accounted for much of the loss.

Ten years' experience now indicates that the brushfields could have been aerially sprayed and planted with caged Douglas-firs and ponderosa pines in the shade of the dead brush. This would have saved at least 5 years in reforesting the site.

MECHANICAL CLEARING AS A RECLAMATION METHOD

In October 1958, when the aerial spray areas were treated, a similar stand of manzanita on a nearby 10-acre area was eradicated and piled by tractor. The piled and windrowed brush was burned. Cost of bulldozing under such conditions is now approximately \$22 per acre.

Planted conifers sustained much less rabbit damage on the mechanically cleared area than under the chemically killed brush. Although rabbits browsed some trees near the edges, they rarely seemed to range beyond a chain (66 feet) from the protective cover--possibly from fear of predators. Survival of planted trees was noticeably better in this opening. Similar results have since been observed on additional mechanically cleared sites in other manzanita brushfields in this area.

Even in mechanically cleared areas, however, an undesirable number of trees may be killed or damaged by rabbits. Protection may be necessary to reduce such damage. On cleared sites in the Rogue River National Forest where rabbits may be a problem, newly planted trees are enclosed in 14-inch-tall, open-ended cylinders of $\frac{1}{2}$ -inch mesh hardware cloth (fig. 1). Each cage (cylinder) is approximately 7 inches in diameter. Initially, the upper portion of the cylinder is sometimes folded above the seedling to provide more complete protection (fig. 2). As the seedling develops, the top is unfolded to allow the tree to grow out of the cylinder. Cages are normally left in place for 3 years, with about 10 percent being lost to cattle and deer damage on a given site during the 3-year period. Since most cages are used repeatedly, cost of constructing and installing cages to protect 300 trees per acre has been estimated at about \$30 per acre. Large-scale commercial production of such cages would undoubtedly reduce this cost appreciably.

DISCUSSION

Experience on these projects on the Rogue River National Forest has shown that this nonsprouting form of greenleaf manzanita can be effectively controlled with aerial spraying. A satisfactory treatment is 3 pounds ae of low-volatile esters of 2,4-D per acre in either water or a diesel oil-in-water emulsion at a rate of 7 or 8 gallons of spray per acre. The spray may be applied during the growing season during spring and early summer, when this manzanita is most susceptible to herbicides. It seems entirely feasible now that such areas may then be planted, but the trees should immediately be protected in hardware cloth cages such as those described to protect the trees from rabbits. The cages should be left in place at least 3 years.



Figure 1.--Cylindrical cage of $\frac{1}{2}$ -inch mesh hardware cloth protects planted trees from rabbit browsing on the Rogue River National Forest.

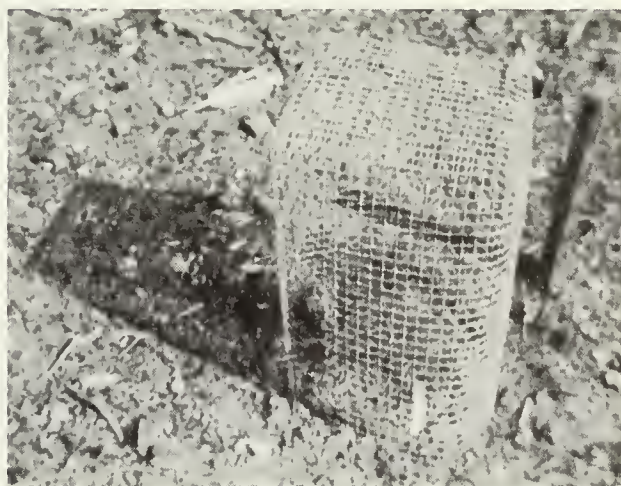


Figure 2.--Tops of cages are sometimes folded over small trees to provide more complete protection; they are unfolded later to allow tree to develop.

To release young conifers from competition of this manzanita, a much lower dosage should be both effective and feasible, for a smaller percentage of crown and shrub kill will satisfactorily release conifers. Experience indicates that release of overtopped Douglas-firs should be possible with an early spring aerial application of about 1.5 pounds ae of 2,4-D in either water or an oil-in-water emulsion containing approximately one-half gallon of diesel oil per acre. The shrubs should be sprayed as soon as possible after brush growth begins and the shrubs are relatively free of snow. Chemicals and aerial spraying to release Douglas-firs from this manzanita should cost approximately \$6 per acre.

Safe and effective methods for releasing ponderosa pines from this manzanita on the western slope of the Cascade Range have yet to be developed. Early spring treatments such as that described for Douglas-fir above severely damage and kill many ponderosa pines.

In central Oregon, however, a satisfactory aerial spray treatment has been devised to release ponderosa pines from manzanita.^{6/} There, 1½ pounds ae of low-volatile esters of 2,4-D are applied per acre in an oil-in-water emulsion containing one-third gallon of No. 2 diesel oil per acre. A total volume of 8 gallons of spray is applied per acre, and 1 pint of emulsifier is added to each 100 gallons of spray. The spray is applied when manzanita is growing but before bud burst on the pines.

On sites where rabbit populations are large and rabbit browsing is apt to be a problem, mechanical eradication by piling and burning or other methods of brush removal should be considered. Such methods should also

^{6/}Region 6 Forest Service Timber Stand Improvement Handbook.

be considered in lieu of spraying and caging for sites where large numbers of trees are to be planted per acre. Trees planted under chemically killed brush should be caged, in most cases, and both planting and caging costs increase proportionately beyond the costs cited when more than 300 trees are planted per acre.

Caging usually will not be as imperative on completely cleared sites. This, however, may depend to a degree on species of rabbits present. Observation on the Rogue River National Forest indicates that brush rabbits (*Sylvilagus nuttallii* Bachman) are more timid than jack rabbits (*Lepus californicus* Merriam). In mechanically cleared areas, jack rabbits have been observed ranging all over the cleared area; while brush rabbits rarely ranged more than a chain (66 feet) from protective cover.

Even in many mechanically cleared areas, however, an undesirable number of trees have been lost or damaged by rabbits. Although caging of planted trees is expensive, cages will be desirable on many areas to protect the investment in clearing and planting costs, to increase survival of planted trees, and thus possibly shorten regeneration and rotation periods for the sites.

Where fire can be used safely, brush eradication similar to that resulting from mechanical clearing might be achieved at lower cost by burning chemically killed brush after aerial spraying.^{7/} ^{8/} Before the

^{7/} Bentley, J.R. Brushfield reclamation in California. Oregon State Univ. Herbicides and Vegetation Management Symp. Proc., pp. 186-195. 1967.

^{8/} Gratkowski, H.J. Use of herbicides on forest lands in eastern and southwestern Oregon. In Herbicides and their use in forestry. Ore. State Univ. Sch. Forest., pp. 65-81. 1961.

Table 3.--Approximate costs^{1/} per acre for alternative methods of brushfield reclamation in manzanita areas on the Rogue River National Forest

Treatment	Methods of brushfield reclamation								
	1	2	3	4	5	6	7	8	9
-----Dollars-----									
Aerial spraying ^{2/}	6.50		6.50	6.50	6.50				6.50
Mechanical clearing		22.00	17.50	17.50		22.00	22.00	22.00	17.50
Burn windrows				2.00		2.00	2.00	2.00	2.00
Bait and trap							4.00		4.00
Planting	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Caging trees					30.00			30.00	30.00
Total costs	31.50	47.00	49.00	51.00	61.50	49.00	53.00	79.00	85.00

^{1/}Based upon 1968 costs.

^{2/}Aerial application of 3 pounds ae of 2,4-D per acre.

sprayed brush is ignited, however, a good fire trail should be constructed with a bulldozer around the area to be burned, and adequate fire control equipment should stand by during burning. Burning should only be done by qualified fire control personnel.

Figures on relative costs of the methods discussed will undoubtedly be of interest to foresters considering brushfield reclamation projects in this and similar brush types. Costs of various operations and alternative methods of treatment based upon experience on the Rogue River National Forest are given in table 3. Not all of these were tried on specific areas, but all combinations of treatments listed are possible. Since these

alternative treatments may be considered by other foresters, we have tried to provide the best estimates of reasonable costs based upon our experience in this brush type over the past 10 years.

SUMMARY

This nonsprouting form of *Arctostaphylos patula* Greene can be controlled with aerial applications of herbicides. A satisfactory treatment is 3 pounds ae of low-volatile esters of 2,4-D per acre in a diesel oil-in-water emulsion at a rate of 7 or 8 gallons of spray per acre. This spray should be applied during the growing season in spring or early summer when the manzanita is most susceptible.

To release young conifers from competition of manzanita, a much lower dosage is recommended. About 1.5 pounds ae of 2,4-D per acre in a water carrier or in an oil-in-water emulsion may be sufficient to provide acceptable results with a minimum of damage to Douglas-firs. Acceptable methods for release of ponderosa pines on the western slope of the Cascade Range have yet to be developed.

Where rabbit browsing is apt to be a problem, mechanical eradication by piling and burning or other methods of brush removal should be considered. Rabbits move about and browse trees planted under standing chemically killed brush in aerially sprayed areas. Where fire can be used safely, a result similar to mechanical eradication might be achieved at lower cost by burning chemically killed brush after aerial spraying. Cylindrical cages of $\frac{1}{2}$ -inch mesh hardware cloth placed around each tree may further reduce mortality by preventing browsing of the trees by rabbits.

Gratkowski, H., and Anderson, Lyle.

1968. Reclamation of nonsprouting greenleaf manzanita brushfields in the Cascade Range. U.S.D.A. Forest Serv. Res. Pap. PNW-72, 8 pp., illus.
Pacific Northwest Forest & Range Experiment Station, Portland, Oregon.

Small plot and aerial spray trials have shown that nonsprouting greenleaf manzanita in the Cascade Range can be killed by a single aerial application of 3 pounds ae of 2,4-D per acre. Conifers planted amid the dead shrubs should be caged in hardware cloth cylinders for protection from rabbit browsing. Less rabbit damage was sustained by trees on mechanically cleared sites than under chemically killed brush. Approximate costs per acre are given for alternative methods of brushfield reclamation.

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